Management of Urinary Tract Infections in Patients with Urinary Catheters

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Urinary tract infections (UTIs) in patients with urinary catheters are among the most common causes of nosocomial infection and are the leading cause of gram-negative bacteremia in hospitalized patients.[1] Incidence in hospitals and nursing homes is greater than 1 million cases each year.[2] There are 1 to 1.5 million catheter-associated UTIs in the United States annually, at an additional cost of approximately $400 per episode. This number accounts for more than one seventh of all UTIs in the United States.[3] This article reviews the prevention, pathogenesis, and treatment of UTI in patients with urinary catheters.

INDICATIONS FOR THE USE OF URINARY CATHETERS

The most effective way to prevent UTI in patients with urinary catheters is to carefully identify situations in which the use of a urinary catheter is indicated and thereby limit its use to selected patients. General indications for the use of urinary catheters include the following[1]:

- Relief of urinary tract obstruction
- Urinary drainage in patients who have bladder dysfunction with urinary retention (eg, some patients with neurogenic bladder or spinal cord injuries)
- Urologic surgery
- Strict measurement of urinary output in critically ill patients

Urinary catheters generally should not be used to obtain urine samples or as a substitute for nursing care in incontinent patients, except when intractable skin breakdown secondary to incontinence is present.

The indications are very different for temporary versus permanent catheter use and are listed in **Table 1**. In cases of acute urinary retention, the catheter should be maintained for variable length of time (from as short as 3 to 5 days in most males with benign prostate hypertrophy up to as long as 2 weeks or more), after which a voiding trial should be performed to ensure appropriate bladder tone.[4–6] Nearly all patients with acute urinary retention need to be referred to an urologist.

PREVENTION OF UTI IN PATIENTS WITH INDWELLING CATHETERS

In a patient with an indwelling catheter, the risk of bacteriuria increases by 3% to 10% each day that the catheter is in place.[7] Bacteriuria is therefore inevitable in patients with long-term urinary catheters. Infectious complications of catheterization are directly related to chronic bacteriuria and include cystitis, prostatitis, epididymitis, pyelonephritis, lithiasis, sepsis, and death.[1,4–6,8,9] The best way to reduce the morbidity, mortality, and associated costs of catheter-associated UTI is to prevent or minimize bacteriuria.

The source of bacteria in UTIs is the urinary meatus. Bacteria enter the urinary tract through the meatus, migrate to the bladder, and proliferate in the urinary tract.[9] Within 8 hours of insertion of a catheter, a biofilm can be found on the surface of the catheter, drainage bag, and mucosa. This biofilm consists of Tamm-Horsfall protein, struvite and apatite crystals, bacterial polysaccharides and glycocalyces, and living bacteria. The presence of the biofilm is thought to be responsible for the persistence of bacteriuria. Prevention should be focused on reducing the entrance and proliferation of bacteria and, thus, slowing the formation of the biofilm. Physicians caring for patients with urinary catheters should follow 2 essential rules: always use a closed collecting system and remove the catheter as soon as it is clinically appropriate.

Strategies to decrease the incidence of catheter-associated bacteriuria and UTI have focused on the use of alternative techniques of drainage, nursing recommendations, use of different catheter materials and sizes, bladder irrigation, and chronic use of antibiotics. The Centers for Disease Control and Prevention groups these

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Table 1. Indications for Urinary Catheterization

Long-term catheterization
Urinary obstruction not amenable to medical or surgical treatment
Neurogenic bladder with urinary retention
Incontinent patient with intractable skin breakdown
Palliative care in terminally ill patient to avoid bed changes
Preference of a patient who has not responded to specific incontinence treatments
Short-term catheterization
Surgery of the urinary tract or contiguous structures
Acute urinary retention
Critically ill patient when strict urinary output measurement is needed

Adapted from Cravens DD, Zweig S. Urinary catheter management. Am Fam Physician 2000;61:369–76.

strategies into 3 categories depending upon the strength of the currently available clinical evidence (**Table 2**).[1] Additional randomized controlled studies are needed to assess the risk of bacteriuria and UTI in patients utilizing these techniques compared with indwelling catheters.

Alternative Drainage Techniques

Various drainage techniques have been developed to reduce the risk of bacteriuria and UTI in selected patients with indwelling catheters. Options include use of intermittent catheterization, use of condom catheters, and suprapubic catheter drainage.[4,8,9]

Intermittent catheterization is the method of choice in ambulatory patients who are able to catheterize themselves. This technique is widely used, especially in patients with spinal cord injuries, and also has been used to improve bladder tone after hip fracture repair.[10] It has been shown to reduce the rate of bacteriuria in some studies. Although intermittent catheterization is a preferred method and is recommended as an alternative to indwelling catheters, no well-designed trials have demonstrated a reduced risk of UTI.[1,9,11–14] This technique may be associated with an increased risk of urethral trauma, urethral stricture, epididymitis, and hematuria.[1,8,9,14]

Condom catheters may be used in incontinent males without urinary obstruction and with an intact voiding reflex. Although commonly used, condom catheters often fall off and leakage may occur. They may be associated with an increased risk of UTI, especially when strict meatal care is not followed and bag drainage is poor. The role of condom catheters remains unclear; a randomized trial is needed to compare their use with that of indwelling catheters.

Suprapubic catheters may reduce the rate of infection, but their use is limited mainly to patients on urologic or gynecologic services.[8] This technique is associated with an increased incidence of bladder stone formation,[8] especially when the catheter is not changed regularly. Although screening for bladder malignancy by cystoscopy and biopsy is commonly performed in patients with neuropathic bladder and a suprapubic catheter, this practice has not yet been useful in early diagnosis of bladder carcinoma.[15]

Table 2. CDC Guidelines for Prevention of Catheter-Associated UTI (December 1999): Summary of Major Recommendations

Category I—strongly recommended:
Catheterize only when necessary
Educate personnel in correct techniques of catheter insertion and care
Emphasize handwashing
Insert catheter using aseptic technique and sterile equipment
Secure catheter properly
Maintain closed sterile drainage
Obtain urine samples aseptically
Maintain unobstructed urine flow
Category II—moderately recommended:
Periodically re-educate personnel in catheter care
Use the smallest suitable bore catheter
Avoid irrigation unless needed to prevent or relieve obstruction
Refrain from daily meatal care
Do not change catheters at arbitrarily fixed intervals
Category III—weakly recommended:
Consider alternative techniques of urinary drainage
Replace collecting system when sterile closed drainage has been violated
Spatially separate infected and uninfected patients with indwelling catheters
Avoid routine bacteriologic monitoring

Adapted from Wong ES. Guideline for prevention of catheter-associated urinary tract infections. Available at www.cdc.gov/ncidod/hip/GUIDE/uritract.htm. Accessed 2 Jun 2004.

CDC = Centers for Disease Control and Prevention; UTI = urinary tract infection.

Nursing Recommendations

Various recommendations regarding hygiene have been proposed to reduce the risk of UTI in catheterized patients. Only some, however, have proven to be beneficial. These include the following[1]:

- Catheters should be handled only by personnel instructed in the aseptic technique of insertion and management
- Strict handwashing should be performed before and after manipulating the catheter

- Sterile technique should be used when inserting the catheter
- The catheter bag should always be connected to a closed system and kept below the level of the bladder
- Bags should be emptied regularly in a separate system for each patient

Measures that have not been proven effective include routine and vigorous meatal cleaning, routine fixed catheter changes (eg, every 3 days), and isolation of patients with UTI in a separate room.[1,14]

Catheter Material

Catheter materials have been evaluated in regard to their antibacterial properties. Latex, silastic, and silver catheters are most commonly used. Latex and silastic catheters have similar long-term outcomes in terms of incidence of UTI.[8,14] Silver-coated catheters (silver oxide and silver alloy) are costly but have been shown to decrease catheter-associated UTI in some studies.[14] More investigations are needed to determine whether they should be used routinely and are cost effective.[14]

Bladder Irrigation

Bladder irrigations using antibiotics (ie, neomycin, polymyxin B) or antiseptic solutions (ie, hydrogen peroxide, povidone iodine, chlorhexidine) have not shown any benefit in decreasing UTI in patients with urinary catheters.[1,4,9,14] An obstructed catheter should always be replaced.

Chronic Use of Antimicrobial Agents

Several studies have been performed to assess the efficacy of prophylactic antibiotics or antiseptics in prevention of bacteriuria and UTI in catheterized patients. The use of antibiotics in the drainage bag also has been proposed. Studies using nitrofurantoin, cephalexin, trimethoprim-sulfamethoxazole (TMP-SMX), nalidixic acid, and methenamine for prophylaxis have yielded controversial results in terms of reducing bacteriuria and symptomatic UTI. Because some have shown a marked increase in resistant organisms,[16–18] chronic antibiotic prophylaxis is not recommended. Patients undergoing short-term catheterization who are at high risk for developing complicated UTI may benefit from a short-term course (3–10 days) of antibiotics.[14]

The use of cranberry juice has been evaluated in children undergoing intermittent catheterization, and in women. Cranberry juice significantly reduces the biofilm of bacteria adherent to the catheter, but its efficacy in reducing UTI has not yet been determined.[3,19]

Prophylactic use of antibiotics may be indicated in specific populations, including patients undergoing transurethral resection of the prostate. The use of antibiotics after this surgery decreases the incidence of postoperative bacteriuria, although no evidence of a decrease in clinical UTI has been demonstrated.[14]

UTI IN PATIENTS WITH URINARY CATHETERS

Presentation and Diagnosis of UTI in Patients with Urinary Catheters

Unlike other categories of UTI (eg, acute cystitis, acute pyelonephritis, complicated UTI), the culture count threshold in catheterized patients is relatively low. A urine culture count of 100 or more CFU/mL is indicative of infection. Antibiotic treatment should be initiated only in the presence of symptoms. The practice of replacing the catheter before obtaining a urine sample in order to better determine the source of infection is a common practice but there are not enough data to support this technique.[5,20]

The use of a urine dipstick to assess pyuria, leukocyte esterase, and nitrites may be used as a screening test. This test is helpful only to exclude UTI in patients with short-term urinary catheters because almost all patients with long-term catheters will have a positive result.[21]

Symptoms associated with UTI in catheterized patients vary widely depending on the characteristics of the patient and the type of infection present. Infections include cystitis, prostatitis, epididymitis, pyelonephritis, and sepsis. In young catheterized patients, symptoms of both lower UTI and pyelonephritis are similar to those in noncatheterized patients. These patients present with local urinary symptoms, back or lower abdominal pain, and fever. Older patients and those who are institutionalized, however, often present with nonspecific symptoms, including fever without an apparent source or altered mental status without fever. In such patients, urinary symptoms (eg, frequency, urgency, dysuria) frequently occur without infection and cannot be reliably used as parameters for suspecting UTI.[21]

Pathogens Associated with UTI in Patients with Urinary Catheters

Escherichia coli is the most commonly isolated organism during short-term catheterization. *Pseudomonas aeruginosa, Klebsiella pneumonia, Proteus mirabilis*, staphylococci, enterococci, and *Candida* species also are common. In patients with long-term catheterization, infections are usually polymicrobial. This fact is important to keep in mind when reviewing culture results from these patients because laboratories tend to interpret polymicrobial cultures as contaminated. *E. coli* is a common pathogen in

polymicrobial infections, associated in many cases with *Pseudomonas aeruginosa*, *Proteus mirabilis*, enterococci, *Providencia* species, and *Candida* species.[4,8,9,22]

Infections caused by *Proteus mirabilis* and *Providencia stuartii* deserve special attention because they frequently are associated with catheter obstruction by struvite and apatite stones. These stones also may be associated with chronic pyelonephritis and renal dysfunction.[9,22–24] *Pseudomonas aeruginosa*, staphylococcus, *Klebsiella* species, and *Ureaplasma urealyticum* also have been associated with struvite stones. In catheterized UTI patients in whom such urease-producing bacteria are isolated, imaging studies to rule out stones should be considered.

TREATMENT OF CATHETER-ASSOCIATED UTI

One of the main considerations in the treatment of patients with urinary catheters is whether to treat asymptomatic bacteriuria or only symptomatic episodes of UTI. Once the decision to treat a patient has been made, it is important to select the most appropriate antibiotic and determine the length of therapy. Urine cultures must be obtained before starting antibiotic therapy.

Asymptomatic Bacteriuria

Asymptomatic bacteriuria generally should not be treated.[4–6,8,9,20,21] If hematuria coexists, investigation for structural abnormalities should be performed, especially in elderly patients. Asymptomatic bacteriuria in patients with long-term catheterization undergoing genitourinary instrumentation and in patients with urinary tract abnormalities generally should be treated.[8,9] These patients may be treated with a short course of TMP-SMX (3 days). A single dose of TMP-SMX also may be used.[4,25]

The significance of asymptomatic candiduria in patients with urinary catheters is not well understood; therefore, recommendations regarding its management are not well defined.[9,26,27] Eradication of candiduria may be achieved using oral fluconazole or bladder irrigation with amphotericin B.[27] Special consideration should be given to candiduria in patients with long-term urinary catheters, including those with structural abnormalities of the urinary tract and in patients undergoing genitourinary instrumentation.

Symptomatic UTI

Treatment of symptomatic UTI in catheterized patients is based on replacement of the infected catheter and selection of an appropriate antibiotic regimen. Removal of the infected catheter is critical because it is the reservoir for bacteria.[9,28] The antibiotic choice and duration of treatment depends on the site and extent of the infection and the results of urinary culture. The incidence of resistant strains is reduced by using the narrowest-spectrum antibiotic available for no longer than necessary. Antibiotic resistance is especially important in patients with long-term urinary catheters. The minimum duration of treatment is 5 days, with an average of approximately 2 weeks. Men may require a lengthier treatment duration because of prostatic involvement.

The choice of antimicrobial agent while awaiting culture and sensitivity results depends on the clinical presentation and comorbidities of the patient. Patients who develop symptoms of lower UTI in association with short-term catheterization who are neither critically ill nor have comorbidities may be treated with a single agent such as TMP-SMX, a quinolone, or nitrofurantoin.[4–6,8] Infections in these circumstances usually are caused by a single organism. Infections in patients with long-term catheterization usually are polymicrobial. If the infection is localized to the lower urinary tract, the patient is not critically ill, and there are no serious comorbidities, TMP-SMX, a quinolone, or a second-generation cephalosporin may be used.[4,7,9,20,29]

In hospitalized patients with severe UTI and in those with sepsis or significant comorbidities, initial treatment with more than 1 parenteral antibiotic is mandatory. The preferred agents are ampicillin plus an aminoglycoside, a third-generation cephalosporin, aztreonam, piperacillin/tazobactam, ticarcillin/clavulanic acid, imipenem, or meropenem, with intravenous quinolones as an alternative. Treatment may be changed to oral agents once the organism and sensitivities have been identified and initial clinical improvement has been achieved. The recommended length of treatment is 2 to 3 weeks.[4,20,21,29] In patients with candiduria and complications including candidemia, renal or perinephric abscess, or fungus balls, systemic therapy with fluconazole or amphotericin B should be started along with appropriate surgical intervention.[9,26] In cases of methicillin-resistant gram-positive organisms, vancomycin is the drug of choice. If the organism is resistant to vancomycin, treatment must be guided by the antibiogram; consultation with an infectious disease specialist should be considered.[8,21]

CONCLUSION

UTI associated with the use of urinary catheters is an important cause of morbidity, mortality, and increased costs, especially in hospitalized and institutionalized patients. The best way to prevent catheter-related UTI is to limit the use of catheters. To obtain urine samples or to measure urinary output, the use of a catheter should be the last resort.

Many strategies have been studied to decrease the risk

of UTI in patients with catheters. The main risk factor for developing UTI is the presence of bacteriuria. The most highly recommended preventive strategies include proper handwashing, aseptic insertion technique, maintaining a closed sterile drainage system, and maintaining an unobstructed urine flow (Table 2). Alternatives to indwelling catheters may be useful in carefully selected patients and include intermittent catheterization, condom catheters, and suprapubic catheters.

Bacteriuria is inevitable in patients with long-term catheterization, and in most cases, treatment should be started only in the presence of symptoms. Special consideration should be given to patients undergoing genitourinary instrumentation and to patients with urinary tract abnormalities. Treatment of UTI in patients with urinary catheters requires replacement of the catheter and selection of antibiotics based on the extension of the infection and the result of the urine culture. **HP**

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